CLAIMS

1. A fuel cell including an anode, a cathode, and an ion exchange membrane therebetween, and having a fuel delivery conduit for supplying fuel from a fuel source to an active surface area of the anode and further comprising means for effecting a controlled combustion of fuel and oxidant species within the fuel delivery conduit.

2. A fuel cell according to claim 1 in which the fuel delivery conduit comprises a fluid flow field plate forming part of the anode, having a fluid flow channel extending therethrough; a fuel delivery inlet coupled to one end of the fluid flow channel; and a fuel delivery outlet coupled another end of the fluid flow channel.

3. A fuel cell according to claim 2 in which the means for effecting a controlled combustion of fuel and oxidant species within the fuel delivery conduit comprises:

a recirculation conduit extending between the fuel delivery outlet and a mixing point in the fuel delivery inlet, and

a fluid flow regulator for controllably varying the quantity of fuel delivered to the mixing point.

4. A fuel cell according to claim 3 in which the mixing point comprises a reaction chamber for reacting fuel from said fluid flow regulator with oxidant species from said recirculation conduit.

5. A fuel cell according to claim 4 in which the reaction chamber includes a catalyst material.

6. A fuel cell according to claim 3 in which the mixing point comprises a pre-mixing chamber for mixing fuel from said fluid flow regulator with oxidant species from said recirculation conduit.

7. A fuel cell according to any preceding claim in which the recirculation conduit is switchably connected to the fuel delivery outlet by way of a two way valve.

8. A fuel cell according to any preceding claim further including detection means for detecting a level of oxidant species present in at least part of the fuel delivery conduit.

9. A fuel cell according to claim 8 in which the detection means comprises means for testing an open circuit voltage across the anode and cathode of the fuel cell.

10. A fuel cell according to claim 3 further including control means for switching the fuel cell between a normal mode of operation in which a relatively high flow rate of fuel is delivered to the anode and oxidant is delivered to the cathode, and a recirculation mode in which a relatively low flow rate of fuel is delivered to the anode together with oxidant delivered via the recirculation conduit.

11. A fuel cell according to claim 3 further including control means for switching the fuel cell between a normal mode of operation in which a relatively high flow rate of fuel is delivered to the anode and oxidant is delivered to the cathode, and a recirculation mode in which a relatively low flow rate of fuel is delivered into fuel delivery conduit together with oxidant delivered via the recirculation conduit.

12. A fuel cell according to claim 2 in which the means for effecting a controlled combustion of fuel and oxidant species within the fuel delivery conduit comprises an oxidant supply conduit extending from an oxidant supply to a mixing point in the fuel delivery inlet.

13. A fuel cell according to claim 12 further including an oxidant flow regulator for controllably varying the quantity of oxidant delivered to the mixing point.

14. A fuel cell according to claim 13 in which the oxidant flow regulator comprises a valve coupling the oxidant supply conduit to a cathode oxidant delivery conduit.

15. A fuel cell according to claim 12 in which the mixing point comprises a reaction chamber for reacting fuel from said fluid flow regulator with oxidant species from said oxidant supply conduit.

16. A fuel cell according to claim 15 in which the reaction chamber includes a catalyst material.

17. A fuel cell according to claim 1 further including means for effecting a controlled combustion of fuel and oxidant species within a cathode fluid delivery conduit.

18. A fuel cell according to claim 17 in which the cathode fluid delivery conduit comprises a fluid flow field plate forming part of the cathode, having a fluid flow channel extending therethrough; an oxidant delivery inlet coupled to one end of the cathode fluid flow channel; and an exhaust outlet coupled to another end of the cathode fluid flow channel.

19. A fuel cell according to claim 18 in which said means for effecting a controlled combustion within a cathode comprises a fuel supply conduit extending from an fuel supply to a mixing point in the oxidant delivery inlet.

20. A fuel cell according to claim 19 in which the mixing point comprises a reaction chamber for reacting fuel from said fuel supply conduit with oxidant species from said oxidant supply.

21. A fuel cell system including:

- a fuel cell having an anode, a cathode, and an ion exchange membrane therebetween;

a fuel delivery conduit comprising:

a fluid flow field plate forming part of the anode, having a fluid flow channel extending therethrough;

a fuel delivery inlet coupled to one end of the fluid flow channel; and

a fuel delivery outlet coupled another end of the fluid flow channel;

the fuel cell system further comprising

a recirculation conduit extending between the fuel delivery outlet and a mixing point in the fuel delivery inlet.

22. A fuel cell system according to claim 21 further including a fluid flow regulator for controllably varying the quantity of fuel delivered to the mixing point.

23. A fuel cell system according to claim 21 or claim 22 in which the mixing point comprises a reaction chamber for reacting fuel from said fluid flow regulator with oxidant species from said recirculation conduit.

24. A fuel cell system according to claim 21 or claim 22 in which the mixing point comprises a pre-mixing chamber for mixing fuel from said fluid flow regulator with oxidant species from said recirculation conduit.

25. A fuel cell system according to claim 21 in which the recirculation conduit is switchably connected to the fuel delivery outlet by way of a two way valve.

26. A fuel cell system according to claim 21 further including detection means for detecting a level of oxidant species present in at least part of the fuel delivery conduit.

27. A fuel cell according to claim 26 in which the detection means comprises means for testing an open circuit voltage across the anode and cathode of the fuel cell.

28. A fuel cell system according to claim 21 further including control means for switching the fuel cell between a normal mode of operation in which a relatively high flow rate of fuel is delivered to the anode and oxidant is delivered to the cathode, and a recirculation mode in which a relatively low flow rate of fuel is delivered to the anode together with oxidant delivered via the recirculation conduit.

29. A fuel cell system according to claim 21 further including control means for switching the fuel cell between a normal mode of operation in which a relatively high flow rate of fuel is delivered to the anode and oxidant is delivered to the cathode, and a recirculation mode in which a relatively low flow rate of fuel is delivered into fuel delivery conduit together with oxidant delivered via the recirculation conduit.

30. A fuel cell system including:

a fuel cell having an anode, a cathode, and an ion exchange membrane therebetween;

a fuel delivery conduit for delivering preconditioned fuel to the anode comprising:

a reaction chamber for reacting fuel and oxidant;

a fuel supply inlet for delivering fuel to the reaction chamber;

an oxidant supply inlet for supplying oxidant to the reaction chamber; and

a reaction chamber outlet connected to the anode;

the reaction chamber being adapted so that at least a part of the fuel supply delivered thereto to is reacted with the oxidant supplied thereto to precondition the fuel being delivered to the anode.

31. A fuel cell system according to claim 30 further including control means for controllably varying the flow rate of one or both of the fuel and oxidant in order to achieve a predetermined degree of humidification of the fuel stream delivered to the anode.

32. A fuel cell system according to claim 30 further including control means for controllably varying the flow rate of one or both of the fuel and oxidant in order to achieve a predetermined degree of pre-heat of the fuel stream delivered to the anode.

33. A fuel cell system including:

a fuel cell having an anode, a cathode, and an ion exchange membrane therebetween;

an oxidant delivery conduit for delivering preconditioned oxidant to the cathode comprising:

a reaction chamber for reacting fuel and oxidant;

a fuel supply inlet for delivering fuel to the reaction chamber;

an oxidant supply inlet for supplying oxidant to the reaction chamber; and

a reaction chamber outlet connected to the cathode;

the reaction chamber being adapted so that at least a part of the oxidant supply delivered thereto to is reacted with the fuel supplied thereto to precondition the oxidant being delivered to the cathode.

34. A fuel cell system according to claim 33 further including control means for controllably varying the flow rate of one or both of the fuel and oxidant in order to achieve a predetermined degree of humidification of the oxidant stream delivered to the cathode.

35. A fuel cell system according to claim 33 further including control means for controllably varying the flow rate of one or both of the fuel and oxidant in order to achieve a predetermined degree of pre-heat of the oxidant stream delivered to the cathode.

36. Apparatus substantially as described herein with reference to the accompanying drawings.

37. A method of operating a fuel cell having an anode, a cathode, and an ion exchange membrane therebetween, comprising the steps of:

supplying fuel from a fuel source to an active surface area of the anode by way of a fuel delivery conduit; and

effecting a controlled combustion of fuel and oxidant species within the fuel delivery conduit.

38. The method of claim 37 further including the step of recirculating fluid within the fluid delivery conduit to a mixing point upstream of the active surface area of the anode.

39. The method of claim 38 further including the step of consuming oxidant species at the mixing point, in a reaction chamber.

40. The method of claim 38 or claim 39 further including the step of controllably varying the quantity of fuel delivered to the mixing point.

41. The method of any one of claims 37 to 40 further including the step of detecting a level of oxidant species present in at least part of the fuel delivery conduit.

42. The method of claim 38 further including the steps of switching the fuel cell between a normal mode of operation in which a relatively high flow rate of fuel is delivered to the anode and oxidant is delivered to the cathode, and a recirculation mode in which a relatively low flow rate of fuel is delivered to the anode together with oxidant delivered in the recirculated fluid.

43. The method of claim 38 further including the steps of switching the fuel cell between a normal mode of operation in which a relatively high flow rate of fuel is delivered to the anode and oxidant is delivered to the cathode, and a recirculation mode in which a relatively low flow rate of fuel is delivered into the fuel delivery conduit together with oxidant delivered in the recirculation fluid.

44. A method of operating a fuel cell having an anode, a cathode, and an ion exchange membrane therebetween, comprising the steps of:

supplying fuel from a fuel source to an active surface area of the anode by way of a fuel delivery conduit; and

reacting fuel and oxidant in a reaction chamber upstream of the anode to precondition the fuel being delivered to the anode.

45. The method of claim 44 further including the step of controlling the flow rate of one or both of the fuel and oxidant in order to achieve a predetermined degree of humidification of the fuel stream delivered to the anode.

46. The method of claim 44 further including the step of controlling the flow rate of one or both of the fuel and oxidant in order to achieve a predetermined degree of pre-heat of the fuel stream delivered to the anode.

47. A method of operating a fuel cell having an anode, a cathode, and an ion exchange membrane therebetween, comprising the steps of:

supplying oxidant from an oxidant source to an active surface area of a cathode by way of an oxidant delivery conduit; and

reacting fuel and oxidant in a reaction chamber upstream of the cathode to preconditioned the oxidant being delivered to the cathode.

48. The method of claim 47 further including the step of controlling the flow rate of one or both of the fuel and oxidant in order to achieve a predetermined degree of humidification of the oxidant stream delivered to the cathode.

49. The method of claim 47 further including the step of controlling the flow rate of one or both of the fuel and oxidant in order to achieve a predetermined degree of pre-heat of the oxidant stream delivered to the cathode.

50. A method substantially as described herein with reference to the accompanying drawings.